THE CRETACEOUS DINOSAURS OF THE TRICHINOPOLY DISTRICT, AND THE ROCKS ASSOCIATED WITH THEM.

BY C. A. MATLEY, D.SC., F.G.S.

I.—INTRODUCTION.

Remains of Dinosaurs were discovered by H. F. Blanford in the Ariyalur Group of the Cretaceous rocks of the Trichinopoly district during the geological survey of that area in the years 1857-60.[1] A "bone-bed" was reported as being situated near Kallamedu (Cullmoad),[2] about six miles from Ariyalur, and numerous bones were seen by him in it, but were so friable and saturated by water that it was impossible to obtain any in an identifiable condition. The best specimen had somewhat the form of a scapula and measured 39 inches in length by 18 inches across at its broadest end. As he found a megalosaurian tooth in the deposit he came to the conclusion that the bones in the bed should also be assigned to *Megalosaurus*. The tooth was afterwards described and figured by Lydekker under the name of *Megalosaurus* sp.,[3] but I can find no further reference in geological literature to the scapula-like bone.

There is no record of any geologist having seen the bone-bed since Blanford's survey of this district. As the remains of dinosaurs are rare in India, and as it is only in this district that they occur in marine beds which contain cephalopoda and other zonal fossils that enable the geological horizon of the bones to be fixed with precision, it occurred to me that it would be worth while to explore this deposit during my visit to India in February 1925. The Director of the Geological Survey of India was sympathetic with my proposal and was good enough to depute one of his Sub-

[1] "On the Cretaceous and other Rocks of the South Arcot and Trichinopoly districts, Madras." *Mem. Geol. Surv. Ind.*, IV, pp. 139-140 (1865).

[2] There are many differences between the spelling of place names in Blanford's memoir and that in the latest *taluk* maps, which I used for my field work. In this paper the spelling in the recent *taluk* maps has been adopted and is followed in some cases by the insertion of the older spelling in parentheses.

[3] *Rec. Geol. Surv. Ind.*, X, p. 41 and *Pal. Indica*, Ser. IV, Pt. 3, pp. 26-27, Plate VI, figs. 6 and 7.

Assistants, Mr. P. N. Mukerjee, to accompany me. I wish to acknowledge the great help Mr. Mukerjee gave me in the field.

Our plan of work was to proceed from Trichinopoly by motor-bus service to a rest-house at Toramangalam, near Perambalur, which stands on the old gneisses, and from there to make a traverse across the lower beds of the Cretaceous succession until the higher beds were reached at Ariyalur. But, on learning that the motor-bus travelled twice daily, we determined to go by the morning service as far as Padalur, pay a hurried visit to the local base of the Cretaceous near Utatur, and complete the journey from Padalur to Perambalur in the afternoon. This little addition to the original plan resulted in the unexpected discovery of some reptilian remains near Neykkulam (Naicolum).

On arrival at Ariyalur, several days were spent in searching for and examining the Kallamedu bone-bed, after which we marched from Ariyalur to Utatur in order to make a further search for reptilian remains at Neykkulam before our return to Trichinopoly. Two traverses were therefore made, one in ascending and the other in descending sequence, across the greater part of the Cretaceous succession. A few remarks on the rocks and fossils will be made in the course of this paper.

II.—THE CRETACEOUS SUCCESSION.

The area occupied by the Cretaceous rocks of the Trichinopoly district is a classic region of Indian geology, and the survey by Blanford, during 1857 to 1860, with the description of the fossils by Stoliczka, was the most detailed piece of geological and palæontological work that had up to that time been undertaken in India. The strata range in age from Upper Albian to Danian, and it may be recalled that Blanford divided them into three groups, a lower or Utatur, a middle or Trichinopoly, and an upper or Ariyalur group. In passing, it may be remarked that the name for the middle group was not well chosen, as the Trichinopoly group is found nowhere near the city of Trichinopoly and it covers a smaller area in the Trichinopoly district than either of the other groups to which local village names have been given.

The rocks consist chiefly of sands and soft friable sandstones, with pebbly bands, among which are beds of clayey sand and clay (often gypseous), calcareous grits and shales, and seams of highly fossiliferous limestone. These strata lie on the Pre-Cambrian

gneisses and granites of the west and south; on the east they are overlain unconformably by the Cuddalore Sandstone, outliers of which are also found in the Cretaceous area. Each group of the Cretaceous transgresses the group or groups below, so that each group in turn rests in part on the basement gneisses. The rocks have a low dip, are little disturbed, form a flattish expanse of country, intersected by sandy *nalas* and are covered in places by regur and other superficial deposits.

I was able to see the nature of the deposits during the two marches between the base of the Cretaceous on the west and Ariyalur on the east, and to collect a few fossils. My fossil list includes the following species:—

I.—*Utatur Group.*

(*a*) 8¼ miles from Perambalur, on the Ariyalur road.
Lima ootatoorensis Stol.
Ostræa cf. *diluviana* Linne.
Exogyra sp. indet.

(*b*) Limestone, north of Odiyam (Odium) village.
Ptychoceras glaber (Whiteaves) Kossmat.
Lima interpunctata Stol.
Pinna intumescens Stol.
Trigonoarca gamana Forbes.
Exogyra haliotoidea Sow.
Turritella nodosa Roemer.

(*c*) Odiyam (Odium) village.
Eucalycoceras sp. (*newboldi* group).

(*d*) ¾-mile S. E. of Neykkulam (Naicolum).
Eucalycoceras? sp. indet.
Acanthoceras sp. cf. *meridionale* Stol.
Turrilites costatus (Lam.) Stol.
Puzosia sp.
Trigonoarca cf. *abrupta* Forbes.
Phasianella incerta Forbes.

II.—*Trichinopoly Group.*

(*a*) Pilimisai (Pelamasey) village.
Scaphites similaris Stol.
Gyrodes pansus Stol.
Chemnitzia undosa Forbes.

III.—*Ariyalur Group.*

(*a*) 14¾ miles from Perambalur, at the bridge on the Ariyalur road, S.E. of Mattur.
'*Holcodiscus*' or '*Puzosia*,' new or malformed.
Trigonia semiculta Forbes.
Eriphyla lenticularis (Goldf.).
Pecten quinquecostatus (Sow.).
Alaria sp. indet.

(*b*) 17 miles from Perambalur, on the Ariyalur road, near Allinagaram.
Modiola typica Forbes.
Leptomaria indica Forbes (covered by *Ostrea*).

(*c*) North-west of Ariyalur.
Ostrea arrialoorensis Stol.
Ostrea vesicularis Lamk.
Plicatula instabilis Stol.
Pecten quinquecostatus Sow.
Anomia sp. indet.
Natica sp. indet.

(*d*) 1 mile W. of Ariyalur.
Hauericeras gardeni (Baily) Stol.
Hercoglossa.
Pecten curvatus Geinitz.
Plicatula instabilis Stol.
Ostrea vesicularis Lamk.

(*e*) 1½ miles from Ariyalur, on the Ottakovil road.
Cyrtoma nov. sp. cf. *planatum* (Forbes) (very abundant).

(*f*) 'Gryphæa' pisolitic limestone, S. of Ottakovil.
Ostrea vesicularis Lamk.
Exogyra ostracina Lamk.

(*g*) Near Ottakovil village.
Ostrea ungulata Schloth.
Radiolites sp. indet.

(*h*) ½-mile N. of Ottakovil.
Stigmatopygus elatus Stol. (very abundant) (=*Cyrtoma herschelianum* McClelland.

III.—THE KALLAMEDU BONE-BED.

The best way to reach the Kallamedu bone-bed from Ariyalur is to take the cart-road to Tamaraikkulam. Here the road forks and there is a choice of taking either the northern road to Ottakovil (Ootacoil) and striking eastwards across country for about 1½ miles, or of taking the eastern cart-track through Venkataramapuram to Kallamedu ("Cullmoad" of Blanford's memoir) from which village the *nala* should be followed northward. The ossiferous bed lies to the west of the *nala* in uncultivated and unenclosed country, and we experienced some difficulty in locating the deposit. Our first attempt resulted only in finding, in small stream-courses, a friable sandstone or sand-rock containing sandy concretions, many of them having a superficial resemblance to bones. Later, we found a few indubitable fragments of bone lying in the bed of the Kallamedu water-course, and by following them up into its eastern branch we at last discovered, on the plateau surface, a bone 36 inches long. More bones were found later in the same neighbourhood. The best indicator for a stranger who may wish to see the deposit is a bed of red clay, mentioned by Blanford (*op. cit.*, p. 139), the brightly-coloured escarpment of which makes a conspicuous feature in the landscape at a mile's distance. The bones should be looked for in the basal part of the sandy beds that lie on the clay.

The beds in which the bones are found are sands containing many sandy nodules and occasional seams of fibrous gypsum. The bones are not numerous, and are scattered. We found ten in all, seven of which were exposed within a radius of about fifty yards; the three others lay, well separated, about 100 to 150 yards away. All of them were found at the surface of the deposit and had been almost completely disinterred by denudation of the surrounding soft sands, so that each formed the crest of a little mound. The region in which they occur is arid, desert-like and shadeless, dissected by small *nalas* or stream-courses and bearing a sparse growth of low xerophytic scrub from which a few goats get what sustenance they can. Blanford appears to have discovered the bed during a monsoon period as he found the bones saturated with water, but at the time of our visit (February, 1925) the ground was very dry, as also were the bones. As was the case in Blanford's time the bones were in bad condition, sub-aerial agencies having played havoc with them. Saturation during the monsoons alternating with desiccation during the dry seasons, and expansion by day

under the intense heat of the unshaded tropical sun followed by contraction at night had split all the bones into fragments, and we found a talus of large and small pieces lying on the slopes around each bone. We spent much time in endeavouring to repair the bones sufficiently in the field to enable them to be conveyed to Calcutta, but our efforts were in vain as the lower surface of each bone was found to be as shattered and damaged as the exposed upper surface. For the following description I have therefore to rely on my field notes.

It is remarkable that all the bones found, ten in number, were limb or girdle-bones, and that not a single vertebra, rib, tooth, scute or other part of the skeleton was discovered. One important result of the examination was to show that these remains do not belong to a megalosaurian, as Blanford supposed, as their characters are quite distinct from those of the Theropoda. They are almost certainly sauropodous bones.

One of the bones was an upper limb-bone, probably a femur, possibly a humerus. Its proximal end and the greater part of the shaft had been badly damaged by exposure to the weather and a long train of fragments lay around it. Its distal end was still embedded, and excavation revealed the two condyles. The shaft was 12 inches across at its narrowest part. Its length as seen was 60 inches, and its full length was probably more. A rough sketch of this bone is given in figure 1. Another bone appeared to be the

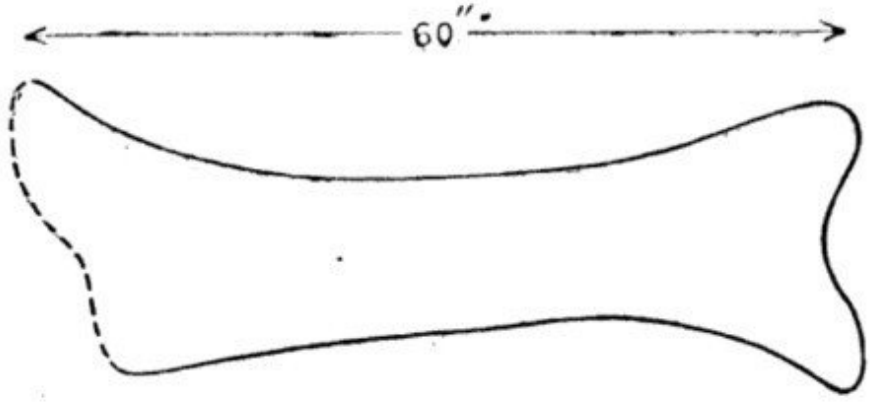

FIG. 1. Restored outline of large limb-bone (femur or humerus) from Kallamedu bone-bed.

proximal end of a great femur, of which the shaft and distal end had been completely destroyed. The part still left measured 23 inches long and 23 inches across. It could not be removed as it was cracked

into small fragments with their edges so corroded that the adjacent fragments did not fit. A third bone was probably part of a large sauropod scapula, but it was badly shattered and only a portion was preserved. One edge formed a concave curve 27 inches long; it was at least 18 inches wide, and had a thin flat expansion at the side opposite the curve.

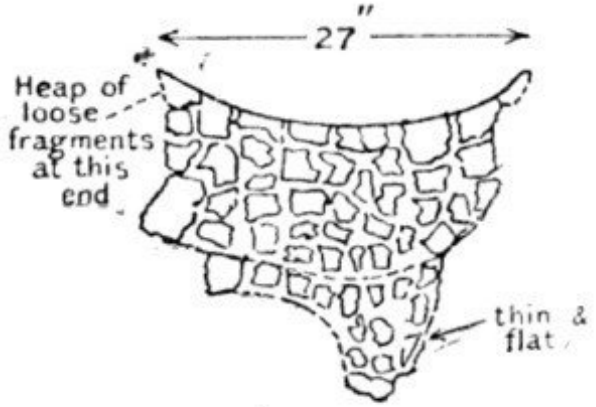

FIG. 2. Disintegrated portion of a bone, possibly a scapula, from Kallamedu bone-bed.

Of the remaining bones three were so fragmentary as to be unidentifiable, but they appeared to be parts of limb-bones. The others were certainly limb-bones. One was originally at least 50 inches long, another 42 inches in length. A length of 36 inches was left of another shattered bone. The last one was a massive limb-bone, destroyed by surface erosion, with fibrous gypsum adhering to parts of its surface.

From the above description it will be seen that the remains belong to one or more gigantic animals. From their shape, size and geological age it is clear that they are dinosaurian. They have the massive and solid character of sauropodous bones; some of the smaller are possibly stegosaurian. None of the bones found is theropodous, though Blanford's discovery of a megalosaurian tooth shows that theropods also lived in this region contemporaneously.[1]

The only Indian genus of dinosaurs, described up to the present time, which attained the dimensions of the Kallamedu reptiles is *Titanosaurus*. The type of the Indian genus (*T. indicus*) comes from Jubbulpore from a Cretaceous horizon which seems to be lower

[1] The presence of Megalosaurids in this area has been confirmed by material recently described by C. R. Narayan Rao and B. R. Seshachar. See the addendum to this paper.

than the Kallamedu deposit,[1] but the genus is also recorded from the highest beds of the Cretaceous system in Patagonia, in France and in Transylvania. It is just possible, therefore, that the Kallamedu bones belong to a Titanosaurid, but their condition is so poor that they cannot be even generically described.

The horizon of the ossiferous sands of Kallamedu can be closely fixed on stratigraphical and palæontological evidence. The Ariyalur group, the highest of Blanford's three groups, is of Upper Cretaceous age, and Blanford subdivided this group into three sub-groups,—a lower (fossiliferous), a middle (almost unfossiliferous), and an upper (fossiliferous) sub-group. The 'bone-bed' of Kallamedu lies near the base of his middle sub-group. Now, the beds at and near Ariyalur itself, in the lower sub-group, are of Upper Senonian and Mæstrichtian age, and there at Sendurai (Sainthorav) and Ninniyur, in the upper sub-group, are Danian. The dinosaurian remains that lie between the two belong therefore to a Mæstrichtian horizon.

The stratigraphical position of the bone-bed in the Ariyalur group is shown in more detail in figure 3. The beds dip very gently to the north or north-east at an angle of usually 2 or 3 degrees, the dip apparently rarely exceeding 5 degrees, and as the country rises from Ariyalur to Kallamedu there is an ascending sequence of the strata. The sands and sandy clays near Ariyalur, which lie some distance above the base of the Ariyalur group, yield the Upper Senonian and Mæstrichtian fauna shown in the fossil list III (*c*) and (*d*) on page 340. Sands with some sandstone bands continue in upward succession up to about $1\frac{1}{2}$ miles north-east of Ariyalur, where, on the Ottakovil road, I found a new fossiliferous locality. The exposure there consists of soft sands (in which I found no fossils) overlain by clayey sand from which I collected about 200 echinoids in half an hour. Only one form is present, a new species of *Cyrtoma* (*Stigmatopygus*) which in shape and proportions closely resembles according to Prof. H. L. Hawkins who has examined the specimens, *Cassidulus planatas* Forbes from the Utatur beds of Moraviatur; and it is associated with many fragments of *Inoceramus* and an occasional gasteropod. More sands follow, and then a bed of sandy pisolite, full f valves of *Ostrea vesicularis*, make a flat tract of uncultivated country. This oyster bed, which is three feet thick in one place

[1] For a discussion of the age of the strata containing *Titanosaurus indicus* and *T. blanfordi* see Matley. *Rec. Geol. Surv. Ind.*, LIII, pp. 157 162 (1921).

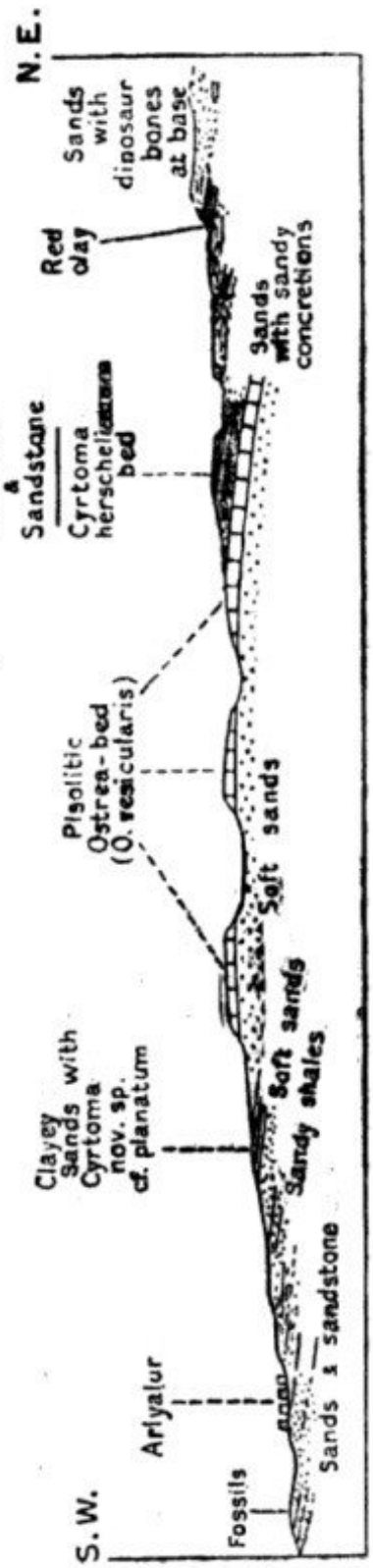

FIG. 3. Section from Ariyalur to Kallamedu bone-bed.

where I measured it, extends for $2\frac{1}{2}$ miles in a N. E. direction towards Ottakovil where it appears to be covered by higher beds. Blanford (*op. cit.*, p. 135) noted the abundance of a "large species of *Gryphæa*" in this district "scattered over the surface," but did not apparently recognise that it formed a persistent bed.

The strata overlying the *Ostræa* bed include the sandy and shaly beds east of Ottakovil where Blanford found (*op. cit.*, p. 135) "one of the richest fossil localities of the formation." The cephalopoda collected by him from these beds are of Mæstrichtian age. My own collection consists only of *Radiolites* sp. and *Ostræa ungulata*, as we had no time to search for the highly fossiliferous band, but Mr. Mukerjee found half a mile north of Ottakovil village an exposure of soft buff sand and sandstone extremely rich in echinoids belonging to a larger species than that found in the echinoid bed nearer Ariyalur. Several hundreds could have been collected at this exposure in an hour or two. The species is generally known as *Stigmatopygus elatus* Stol., but Prof. H. L. Hawkins, who has kindly studied my specimens, tells me that it has been described earlier (1840) by McClelland as *Cyrtoma herschelianum*. The geological position of this echinoid bed is probably a little lower than Blanford's cephalopod bed mentioned above. Sandy strata continue above the fossiliferous horizon until the red clay band is reached on which the dinosaurian bed lies. About two miles further on comes the fossiliferous Danian zone of Sendurai and Ninniyur, which I have not been able to visit.

During our search for dinosaurian bones around Kallamedu we made an interesting discovery of fossilised mammalian remains. We picked up a number of teeth and pieces of jaws of *Bos* (or *Buffelus*) and *Equus*, lying in and around the Kallamedu Nala, which differed from the remains of domesticated animals (which also are found) by being heavy and decidedly mineralised. I brought some of them to Calcutta and they are now in the collection of the Geological Survey. Dr. G. E. Pilgrim thinks they may have been derived from the Cuddalore Sandstone, which he regards as of Pliocene age. There is no doubt that the Cuddalore Sandstone once overlay this area, but Blanford's map shows no outlier in the drainage basin of the Kallamedu Nala. The fossils therefore suggest that either a small outlier has not been mapped or the denudation of one has recently been completed. They also suggest that the mammalian horizon is at the base of that sandstone.

IV.—VERTEBRATE REMAINS IN THE UTATUR GROUP.

In Blanford's memoir there is a reference to a supposed discovery of dinosaurian remains in the Utatur beds by Adolphe Schlagintweit in 1856. The passage reads as follows:—

> 'The late Mr. Adolphe Schlagintweit also paid a brief visit to the known localities of the Cretaceous rocks in the early part of 1856, and published a brief notice of his observations, which was reprinted in the 2nd number of the Journal of the Asiatic Society, Bengal, for 1857 (Vol. XXVI, page 109). Except the important discovery of the remains of a gigantic Saurian, supposed to be an *Iguanodon*, near Ootatoor, there is but little referring to the Cretaceous rocks in Mr. Schlagintweit's paper that had not been noticed by previous observers.' (*op. cit.*, p. 9).

The paper quoted by Blanford, however, contains not the slightest reference to the alleged discovery, nor can I find any allusion to it in any other contemporary publication. As it seemed unlikely that Blanford would have made his statement without some foundation I wrote on the subject to Mr. T. H. D. LaTouche who after enquiries ascertained that A. Schlagintweit's journals are preserved in the State Library at Munich, and obtained, by the courtesy of Prof. Dr. Leidinger, a copy of the explorer's manuscript field-notes relating to his visit to Utatur and neighbourhood in March 1856. They show that he found a large bone at Garudamangalam in a soft yellowish sandy bed containing ammonites, close to the outcrop of the hard shelly limestone known as 'Trichinopoly marble.' This bone, the only one found, was a piece of a long bone but it had no special characteristics and was unidentifiable. No dimensions are given. He makes no mention of Iguanodon, or even that the bone is reptilian. The supposed discovery of Iguanodon in India must therefore be disregarded. Blanford himself makes no further allusion to it, and his only mention of vertebrates in the Utatur group is on page 78 of his memoir, where he says that their remains are 'very scarce, the vertebræ and teeth of a fish (a shark) and a few bones of doubtful nature being the only instances of their occurrence.' The Utatur area was searched later for fossils by R. Bruce Foote, who in his "Rough Notes"[1] records the discovery of large vertebræ of Ichthyosaurus (afterwards described by Lydekker) and sharks' vertebræ and teeth, but he found no other reptilian remains.

[1] *Rec. Geol. Surv. Ind.*, XII, pp. 159-162 (1879).

During our visit to Utatur and neighbourhood, however, we discovered a large number of reptilian remains at a locality half a mile east of Neykkulam (Naicolum). They occurred in black soil (regur) overlying buff sand and soft sandstone of Cenomanian age and consisted of about 650 fragments of dermal armour accompanied by a few spine-like objects and some bones. All the specimens were collected from a tiny area not more than a square yard in extent and were found close to the surface and down to a depth of 12 inches. Each was coated with a thick incrustation of carbonate of lime. The scutes and spines appeared to represent part of the armour of a Stegosaurian, and they were described as such in a short preliminary note read to the British Association at Southampton in August 1925,[1] but the incrustation has since been removed from the material and further examination shows that some of the small bones are chelonian and that many of the 'scutes' may be smashed fragments of a carapace. There are difficulties in accepting the whole of the material, especially the spine-like objects, as chelonian, but pending the completion of the study of these bones it will be better to regard as cancelled the statement that they are dinosaurian.

V.—CONCLUDING REMARKS.

It will be seen from the above account that at least two groups of dinosaurs survived in Southern India up to almost the close of Cretaceous times. The Mæstrichtian beds of the Ariyalur group of the Trichinopoly district contain the remains not only (as was previously known) of carnivorous saurischia (Megalosaurids) but also of gigantic sauropoda, possibly Titanosaurids. There is a possibility that dinosaurian remains occur also in the Utatur group.

It is also recorded that fossil teeth and portions of jaws of *Bos* (or *Bubalus*) and *Equus* occur in the Ariyalur area and have probably been derived from the Cuddalore Sandstone.

In conclusion, I desire to express my grateful thanks to the staff of the Geological Department of the British Museum (Natural History) for identifying the invertebrate fossils recorded in this paper, and to Prof. H. L. Hawkins for examining the echinoids, which appear to be of limited vertical range and may define two palæontological zones.

[1] Rep. Brit Assoc. for 1925 (1926), p. 314.

VI.—ADDENDUM.

Since the above paper was written my attention has been called to two papers published in the Half-Yearly Journal of the Mysore University (Vol. I, No. 2 for July 1927),[1] from which I learn that the Ariyalur area has been recently visited by the geology students of the University, under the direction of Prof. P. Sampat Iyengar, and also by the zoology students. These two parties have been fortunate in finding a number of dinosaurian bones, including a vertebra, ilium, scapula, coracoid, head of a humerus, a tooth with a portion of the dentary, and limb bones mostly in a broken condition. This discovery is of importance as it is the first time that Southern India has yielded identifiable remains of dinosaurs. In the preliminary account of them given by the authors the tentative conclusion is arrived at that "the fossils must belong to a dinosaur reptile hitherto undescribed." From their account and figures it is clear that a theropodous dinosaur is represented in the collection, and sauropodous or stegosaurian bones are probably also present.

Owing to the construction of a new railway line from Trichinopoly Junction to Villupuram, the Ariyalur area has become much more easily accessible to geological investigation than it was at the time of my visit. It is to be hoped, therefore, that more geological visits will be paid to this interesting area, and that any further bones discovered will be carefully preserved and submitted for scientific examination.

---

[1] C. R. Narayan Rao and B. R. Seshachar, 'A Short Note on Certain Fossils taken in the Ariyalur Area (S. India),' pp. 144-152; and L. Rama Rao 'Notes on the Upper Cretaceous Rocks near Ariyalur, S. India,' pp. 153-7.